PART 16

OPERATION AND MAINTENANCE

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PART 16

OPERATION AND MAINTENANCE

16.1 Operation and Maintenance Requirements

This section applies to the specifications of materials used for operation and maintenance, the workmanship, period for routine maintenance, specifications for the acceptable quality of plant effluent, maintenance of records, and responsibilities during the Operation Service Period. The Contractor shall provide access to the Site for the Employer/Employer's Representative for the purpose of monitoring the Contractor's Operation Service activities during the Operation Service Period. The Contractor shall train the Employer personnel who will operate the Works/plants (Refer to Part 15). Entering into AMC contracts with system / equipment suppliers including but not limited to Centrifuges, Air Blowers, Hoists and cranes, Valves and actuators, Sluice Gates and actuators, all pumps and mixers, Chlorinators, DG sets, PLC & SCADA system integrator, lab equipment integrator and all proprietary equipment and others as necessary.

The Contractor shall operate and maintain Tertiary Treatment Plant (TTP) under the Contract complete including the road works, landscaping, civil/structural, mechanical components, instrumentation system, Electrical System of TTP, SCADA systems, all utility and ancillary buildings, and TTP premises areas for the period of five (5) years from the date of the Commissioning Certificate, in accordance with the Conditions of Contract.

The Contractor shall manage plant operations so as to restrict power consumption and chemical usage within the specified functional guarantees.

The Contractor shall ensure satisfactory operation and maintenance of the whole works so that the plant operation provides reliable, consistent performance and is economical at all times.

The Contractor shall make his own arrangements at his own cost for plant operation personnel, chemicals usage, lubricants, diesel, spares, tools and tackles, routine maintenance, sampling and analysis, screenings and grit collection, transportation and disposal, dewatered sludge disposal/sale, co-ordination with Employer, Karnataka State Pollution Control Board (KSPCB), Karnataka Power Transmission Corporation Ltd. (KPTCL) authorities and any other activity required for the operation and maintenance of the works / plants in full compliance with all applicable rules, regulations, laws, codes, effluent quality requirements and any other limitations.

Normally shut down time shall be considered as Average two (2) hrs per day. Contractor shall pay for diesel charges for running the TTP for this period. Employer will pay for any additional consumption of diesel when power shutdown period exceeds Sixty (60) hours per calendar month to a TTP.

The cost of electrical energy consumed for the operation of the Plant will be borne by Employer up to the amount corresponding to the guaranteed specific energy consumption specified by the Contractor in the Technical Schedule VI or as agreed between BWSSB and the Contractor. However, Contractor shall bear the additional electrical energy consumption charges above the amount calculated as per Technical Schedule XI.

During the Operation Service Period, the Contractor shall collect, transport, and dispose of the screenings, grit, and dewatered sludge cake in full compliance with all applicable laws, rules, and regulations.

The Contractor shall submit a weekly and monthly report to the Employer detailing the Operation and Maintenance indicating the labour hours expended, Electrical Power Consumed, Chemicals and other

Consumables consumed and also any problems including troubleshooting faced and rectified. The report shall also include full details including photos and complete results of all sampling and analysis conducted. The sampling locations, parameters analysed, and sampling/analysis frequencies shall be as listed in the "Sampling/Analysis Locations and Frequencies" table in the "Sampling and Analysis" section of Volume 2, Part 5 of these Bidding documents, as a minimum.

The Contractor shall submit detailed schedule/manual of all O&M activities and contents with references of equipment manufacturer's maintenance schedules/manuals to the employer for review and approval.

The Contractor shall carry out all O&M activities as per the approved Operation and Maintenance Manuals, including updated and approved Manuals based on operation and maintenance experience.

During the Operation Service Period, the Contractor shall ensure that the stipulated design effluent standards and sludge quality are met in accordance with the specifications in the Bidding Document/Contract.

The Contractor's responsibility shall also include the safety and security of the Works / plants during the course of Operation and Maintenance.

During the Operation Service Period, the Contractor shall appoint a Plant Manager, Shift-in-charge, Plant Operators, Plant Chemists, Fitters/Mechanics, Electricians, Instrumentation and Control Technicians, gardeners/peons, watchman and helpers as required for the operation and maintenance of the Works/plants (TTP) for three shifts and adequate other staff / supporting personnel during general shift.

Key and other O&M personnel shall have minimum qualification and experience as given below, which also shows the minimum number of staffs per designation at each TTP location:

16.1.1 Minimum Number of Staff per Designation and Qualifications Requirements during Operation Service Period for TTP.

Designation	Minimum Qualifications and Experience	Shift			Total for One plant
		1	2	3	
Plant Manager cum Process manager	Should have minimum 10 years of relevant experience after completion of Graduate/ Post Graduate in Civil, Public Health, or Environmental Engineering with specialization in wastewater collection and treatment and having experience in TTP and Commissioning, Operation & Maintenance, Liaison with Government, Pollution Control Authorities. Shall have completed at least one CPHEEO advanced Wastewater Operations course or equivalent.	1 No for General Shift			1
Plant Operator cum Shift-In-Charge	Should have minimum 7 years of relevant experience after completion of Diploma in Mechanical/ Electrical with specialization in wastewater collection and treatment. Shall have completed at least one CPHEEO advanced Wastewater Operations course or equivalent.	1	1	1	4
Plant Chemist	Should have minimum 3 years of experience after completion of Graduate in Environmental Science / Chemistry having experience in TTP laboratory (sampling / analysis)/ operation and maintenance.	1 No for General Shift			1

Designation	Minimum Qualifications and Experience	Shift			Total for One plant
		1	2	3	
Electrician	Should have minimum 3 years of experience after completion of Diploma/ ITI Certification in Electrical Engineering with experience in TTP & Erection, Testing, Commissioning, and Operation & Maintenance.	1	1	1	4
Instrumentation and Control Technician	Should have minimum 4 years of experience after completion of Engineering / Diploma in Instrumentation and Control Engineering with experience in TTP & Erection, Testing, Commissioning, and Operation & Maintenance including PLC/SCADA based system.	1 No for General Shift			1
Fitter / Mechanic	Should have minimum 3 years of experience after completion Diploma / ITI Certification in Mechanical Engineering with experience in TTP & Erection, Testing, Commissioning, and Operation & Maintenance.	1	1	-	2
Security		1	1	1	4
Gardener		1	1	1	3
Helper		1	1	1	4

Note:

a) *The above specified requirement is **Minimum for TTP**, Further, Contractor shall arrange extra work force, as and when required, so as to smoothly run the operation and maintenance including preventive maintenance, repairs etc. and general cleanliness of the installations.*

b) *The above staff strength is exclusive of leave reserve required for different category of staff. The Contractor shall ensure availability of the personnel given in the above table for all seven days in a week.*

c) *The Contractor shall make appropriate arrangements for maintenance of items like road work, buildings, arboriculture, patrolling and maintenance of civil structures, vehicle operations and other activities defined to fulfill its obligations under the Contract during the O&M Period*

d) *Employer may/might appoint one Plant Operator (General shifts) for TTP in addition to contractor's operational staff. Contractor should make Employer's Operator involved in all day-to-day Operation and Maintenance activities of TTP. Employer's Operator shall report to concerned Engineer from Employer and wages towards Employer's Operator shall be directly paid to Employer's Operator from Employer. Contractor shall make note that Employer's Operator is not authorized to certify any of the Contractor's monthly O&M bills; however, Employer's Operator responsibilities shall be similar to the responsibilities of Plant In charge and/or Plant Manager. (Refer Part 15 of Tender Document).*

The Contractor shall furnish complete resumes/bio-data to the Engineer for approval of all personnel proposed two months before the start of the Operation Service Period.

16.2 Health and Safety

S. No.	Item	Description
1	Chlorination	- All personnel who are assigned to use chlorine shall first be trained to understand and follow all aspects of procedure and safety; Training shall include the potential hazards related to poor personal hygiene and unsanitary practices.

S. No.	Item	Description
		- Chlorine handlers shall be instructed to report any condition that may affect their personal hygiene to their superiors.
2	Electricity	- All the electrical equipment shall be handled and operated by a trained and authorized person only. All the equipment shall be checked for its proper earthing and loose connections prior to start the equipment. Naked wire, loose connections and faulty connections shall be repaired immediately prior to start for operation. - Electrical sockets and switch shall not be touched by bare or wet hands. If there is any live wire found naked or on wet ground, main switch shall be turned off first then the wire shall be repaired or moved. - For any electrical works, proper insulated tools shall be used. Do not try to use tools made for other purpose; it may be hazardous.
3	Fall protection	- Only authorized person shall work at high place, people working at high level shall be very careful and protect himself from fall and injuries. Protective gears such as gloves, safety belts shall be worn and safety belts shall be tied to a proper location prior to starting the work. If anybody feels dizzy and drowsy, he should not work at high and should come down immediately. - Wherever possible a ladder shall be used. Ladders shall be in stable condition and proper slope of ladder is 4 vertical and 1 horizontal and they shall be properly secured at base. - All the openings shall be secured properly by barrier of handrail to avoid unauthorized person getting in. Wherever covers are provided for opening those covers shall keep closed all the time, except for maintenance time.
4	Entering inside tanks and other confined space entry including all unit process and pumping stations	- Special precaution shall be taken, if worker(s) enter inside manholes or tanks (especially deep manholes or tanks). Personal entering to the deep manholes or tank must possess complete Self-Contained Breathing Apparatus (SCBA). - Manholes cover shall be open and wait for fresh air to circulate. - Prior to entering Methane and Hydrogen Sulphide level inside the tank shall be checked otherwise it may be hazardous. If oxygen is not enough a ventilating fan should be used to supply fresh air inside. - Only permitted person shall work inside, while a person is working inside there must be another person watching outside; unless he appoints a replacement person he should not leave from duty. While men are working inside manholes, the manholes must be kept open and manholes shall be protected such that staffs who are not engaged by the Contractor do not go inside the manhole. - If a person inside feels drowsy, dizzy or unusual feeling he should leave immediately. He should rest and take fresh air. - If the worker is collapsing inside, do not immediately enter inside to

S. No.	Item	Description
		rescue him as you may be next victim of accident. Prior to rescue make sure that oxygen inside is sufficient and report immediately to the person in-charge. Try to rescue the person from outside.
5	Health check up	- Water can be scrapped and become a carrier of water borne disease if it is handled by an ill person. That's why personal health is an important factor to keep the water potable. Any person not feeling well shall report to their superior and shall be go through proper health checkups. - All workers should go through medical checkup every year, and the result of checkup shall be reported to the Engineer. - Contractor shall organize Biannual health camps for all O&M workers
6	General personnel's cleaning	- Persons working on sewerage and sewage treatment shall maintain a high level of personal hygiene. This includes clean work clothes, skin, fingernails, and hair. They should wash their hands properly by using soap and clean water prior to handle the sewerage works.
7	Uniform	- All workers at site work shall wear helmet, safety shoes, and regular uniform to avoid any accident by rotating equipment or by any other means including unforeseen events.
Notes: *Contractor shall prepare and submit the safety action plan 60 days prior for review and approval.*		

16.3 Definition of Maintenance

Maintenance covers all the techniques and systems which, by means of regular monitoring of equipment and scheduled maintenance procedures, prevent failures and, in the event of problems, enable repairs to be carried out with the minimum disruption of the process. Maintenance is therefore a combination of technical, administrative, and management activities. Maintenance consists of preventive, predictive and corrective procedures.

16.4 Preventive Maintenance

Preventive maintenance consists of all the regular work carried out in order to sustain the conditions necessary or smooth operation of the plant and to keep the performance of the equipment as close as possible to its original performance level. Its purpose is to reduce the probabilities of failure of deterioration of equipment of the plant. In simple terms, preventive maintenance involves elementary operations such as lubrication, mechanical servicing, electrical and instrumentation servicing.

16.5 Corrective or Remedial Maintenance

Corrective or remedial maintenance consists of all work needed to re-establish the conditions necessary for an apparatus or set of equipment to operate properly subsequent to failure or deterioration of the results produced by the equipment. It includes the following operations:

- Dismantling of equipment,
- Replacement of parts

The work may be scheduled for the short or medium term in accordance with the checks carried out as part of the preventive maintenance procedure, the number of hours an apparatus has been operating,

or an alarm factor (abnormal noise, repeated cut-out, weakening of the insulation, etc), or may be dictated by an unexpected breakdown.

I. Maintenance work

The work consists of inspection work and maintenance work as mentioned below:

- Inspection work, that includes physical appearance, inspection and measurement with testing equipment to verify and survey whether the plant performance/operation is normal or not.
- The inspection work shall be executed daily by each technical specialist as a routine and/or regular inspection and shall be recorded and trended each and every time. The evaluation of the collected data shall be immediately reviewed by the Plant Manager/Shift-in-charge to instruct the staff member for operation on the same day and/or make a plan of detail inspection and/or make repair schedule to make sure continuous plant operation without any problem.
- Maintenance work, for which main task-work shall include activities, such as lubrication, overhaul, replacement of parts, repair, adjustment, detail examination and test, cleaning, to maintain the plant in a good condition, performance consistent and low-cost operation based on a regular and preventive maintenance schedule including attending sudden equipment breakdown and to achieve high operational efficiency.

II. Operation work

This work consists of operation work and monitoring work:

- Operation work is executing the plant operation based on the scheduled process and procedure to meet designed criteria including set-up or adjust the operational index or data according to the water quality or demand.
- Monitoring work is to confirm the operation data, readout its measurement value on panels, and check-up the working performance of plant appropriately, as well as keep the records of the output.
- Prepare and present running trend graphics, for use in process adjustment and optimization of power and chemical consumption.

16.6 Material Specifications

The specification of materials used for repairs shall be the same as have been used in the original work. Specifications for any materials which were not used during construction shall be approved by the Engineer prior to commencement of the operation and maintenance period and must be incorporated in the O&M Manual. Without being limited by this clause, during the Operation Service Period the Contractor shall use appropriate material for repairs even if material required for such repairs has not been approved earlier, and no delay in making such repairs shall be subjected to such limitation. However, subsequent to use of such material the Contractor shall submit proposals for the approval of specifications of such material. The approved material will subsequently form a part of the O&M Manual. The comprehensive information as detailed in below Table shall be submitted to the Engineer.

List of Execution Schedule:

Items	Description
Maintenance of plant/ facilities	List of unit processes, Capacity of equipment's, Method/ Frequency of maintenance.
Operation of plant/facilities	List of plant/equipment, Items to be monitored/operation

Items	Description
	procedures, Preparation of chemical, handling sludge, Method of system control and its note, how to input data into computer, operation of backup, Period of Power failure and generator operation, communication method.
Monitoring of effluent quality and reporting	Scope of monitoring, Method of sampling and analysis, Place of laboratory and name of authorized personnel.
Countermeasure against accident and risk management	Damage prediction, Simulation of public relations, Method of recovery, Contact address, Rescue activity and emergency team.
Renewal	Replacement of pipes, Replacement of equipment & Facilities.
Subcontracting	Method of contract out, Scope of works, limit of responsibility.
Evaluation & Report	Method of data analysis, Evaluation of collected data, Improvement program, Reporting.
Organization and administration	Executive organization chart, Structured communication plan, Segregation of duties, List of staff member, Experience, Health certificate of staff member, type of insurance, Criminal record, Personnel name of taking record and make soft data, method of data control, Operation and maintenance cost.

16.7 Typical Items in TTP Maintenance Requirements

The main items of preventive maintenance work are shown below.

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
Motorised Gates	- Check Smooth-Operation - Check safety equipment	Weekly	- Check oil levels and Greases - Smoothness of operation (Fully open & Close)
		Monthly	- Check opening-and-closing time
Wet well, Channels and Chamber	- Removal of floating matter - Check of water level	As needed basis	- Cleaning of sediment - Check H_2S gas concentration
Screens	- Check Smooth-Operation - Check of the difference of the water level before and behind a screen - Remove un-removable floating matter on screens - Clean-up drop garbage - Clean-up Top of Screen	Monthly	- Adjustment of take-up for Drive chain - Check Screen- shape - Check Operation of a wiper - Adjustment of space between rakes and a screen - Check of the lubricating oil level of reduction gears

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
	- Check abnormal noise - Check safety equipment - Check manual cleaning equipment Correctness		- Check Rake-speed - Check emergency stop system
Screening Conveyor	- Check Smooth-Operation- - Abnormal noise - Meandering of a belt - Check rollers-performance - Cleaning of Conveyor - Check safety equipment	Weekly	- Grease up & Oil
		Monthly	- Check Damage to a belt/screw - Check Slack of a belt/screw adjustment of take-up - Check of an emergency shutdown system - Check Belt-speed/screw speed
Submersible Pumps	- Check Smooth-Operation - Check discharge rate, pressure, abnormal noise, Vibration - Checkup minimum submergence in wet well - Check safety equipment - Position of valve	Monthly	- Check pump damage - Check the pump lifting equipment for performance and smoothness
		Every 6 Months	- Check wear on pump impeller - Check Oil level and grease up - Check bearings
		Every 1~3 Year	- Check pump performance & wear on pump impeller
Monorail Motorized Hoist	- Check Smooth-Operation - Check all lifting equipment including wire and hook - Check lifting and traveling performance. - Check safety equipment	Monthly	- Check End-stop system
		As needed basis	- Check traveling speed - Check hoist rails, structure & support - Check deflection of girder
Valves	- Check water leakage	As needed basis	- Check seal - Check damage

16.8 Maintenance Practices for TTP - Mechanical

The main items of preventive maintenance work are shown below.

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
1.HEAD WORKS/FINE SCREEN INLET CHANNELS			
Screens	- Check Smooth-Operation - Check of the difference of the	Monthly	- Check Screen-shape - Operation of a wiper

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
	water level before and behind a screen - Remove un-removable floating matter on screens - Clean-up Top of Screen - Check abnormal noise - Check safety equipment - Check manual cleaning equipment Correctness		- Adjustment of space between rakes and a screen - Check of the lubricating oil level of reduction gears - Check emergency stop system
Screenings Conveyor	- Check Smooth-Operation - Abnormal noise - Meandering of a belt - Check Smooth-Operation - Check scraper performance - Check rollers-performance - Cleaning of Conveyor - Check safety equipment	Weekly	- Check Grease up & Oils - Check emergency stop system
		Monthly	- Check Damage to a belt/screw - Check Slack of a belt& adjustment of take-up - Check Belt/screw speed
2. PROCESS AIR BLOWER BUILDING			
Air Blowers	- Check Smooth-operation - Check discharge rate, pressure, abnormal noise, heat and vibration - Check blower speed & rotation direction - Check coupling connection - Check cooling system - Check air leakage - Check safety equipment	Weekly	- Check grease up & Oil level of reduction gear box - Check safety equipment - Check Air filter - Check drain
		Every 1~3 Year	- Check Blower performance
		As needed basis	- Check blower system - Check Silencers
EOT Crane/Hoist	- Check Smooth-operation - Check all lifting equipment including wire and hook - Check lifting and travelling performance - Check abnormal noise and vibration - Check safety equipment	Monthly	- Check End-stop system
		As needed	- Check travelling speed - Check rails, structure and support - Check any damage
Alum Dispersion Raid Mixer	- Check coagulation condition in secondary clarifier - Check abnormal noise & vibration	Every 6 Months	- Check the mixer lifting equipment for performance and smoothness - Check mixer damage

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
	- Check safety equipment		- Check smoothness of mixer operation - Check mixer speed & performance
3.HEAD WORKS/GRIT CHAMBERS			
Grit Collectors	- Abnormal noise - Check Smooth-Operation - Check safety equipment	Weekly	- Check grease up & Oil level of reduction gears - Remove scum& cleaning - Check emergency stop system
		Every 6 Months	- Check of shaft rotation speed
		Yearly	- Dry basins for checking of damage, velocity, repair, painting & cleaning
Organic return Pumps for Grit and grease removal Chamber	- Check Smooth-Operation - Check discharge rate, pressure, abnormal noise, heat &vibration - Check liquid leakage - Check pump rotation direction - Check safety equipment	Monthly	- Clean up with water
		Every 6 Months	- Check pump damage -Check wear of pump impeller
		Every 1~3 Year	- Check pump performance & wear on pump impeller
Grit Classifier Equipment for Grit and grease removal Chamber	- Check Smooth-Operation - Check discharge rate, abnormal noise - Check liquid leakage - Check safety equipment	Weekly	- Check grease up & Oil level of reduction gear box - Remove scum &cleaning - Clean up with water
		Monthly	- Check emergency stop system
		Every 6 Months	- Check of shaft speed - Check for damages
Grit Conveyor	- Check Smooth-Operation - Abnormal noise - Meandering of a belt - Check Smooth-Operation - Check rollers-performance - Cleaning of Conveyor - Check safety equipment	Weekly	- Check grease up & Oils - Check emergency stop system
		Monthly	- Check damage to a belt/screw - Check Slack of a belt& adjustment of take-up - Check Belt/screw speed
4.Bioreactor Tanks			
Mixers	- Check mixing condition in the zone	Every 6 Months	- Check the mixer lifting equipment for performance and smoothness

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
	- Check abnormal noise - Check safety equipment		- Check Mixer damage - Clean up with water
		Yearly	- Check smoothness of mixer operation - Check wear mixer impeller - Check Mixer speed &rotation direction
Internal recirculation pumps	- Check Smooth-Operation - Check discharge rate, pressure, abnormal noise - Check safety equipment	Monthly	- Check pump damage - Check the pump lifting equipment for performance and smoothness - Cleaning up with water
		Every 6 Months	- Check wear of pump impeller - Pump speed & rotation direction
		Every 1~3 Year	- Check pump performance
5. CHEMICAL BUILDING (Alum Building)			
Alum Solution Tanks	- Check corrosion condition - Check leakage - Check drain & Overflow pipe	Weekly	- Remove deposition substance - Clean up tank &touch-up painting
Alum Solution Tank Mixers	- Check Smooth-Operation - Check abnormal noise& vibration - Check mixing time - Check safety equipment	Weekly	- Clean up mixer
		Monthly	- Check mixing speed - Check shaft and coupling connection
Alum Dosing Pumps	- Check Smooth-Operation - Check discharge rate, pressure, abnormal noise, heat and vibration - Check safety equipment	Monthly	- Check accuracy of flow rate through calibration - Clean up with water
		Every 1~3 Years	- Check pump performance
Flow Indicator	- Check flow indicator - Check safety equipment	Weekly	- Check accuracy of flow rate - Clean up with water
Monorail Motorized Hoist	- Check Smooth-Operation - Check all lifting equipment including wire and hook - Check lifting and travelling performance - Check safety equipment	Monthly	- Check End-stop system
		As needed basis	- Check travelling speed - Check hoist rails, structure & support

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
6. RETURN/WASTE ACTIVATED SLUDGE (RAS/WAS) PUMP			
Return/Waste Activated Sludge Pumps	- Check Smooth-Operation - Check discharge rate, pressure, abnormal noise, heat and vibration - Sludge leakage - Check safety equipment	Monthly	- Clean up with water
		Every 6 Months	- Check pump impeller - Check flow rate
		Every 1~3 Years	- Check pump performance
Monorail Motorized Hoist	- Check Smooth-Operation - Check all lifting equipment including wire and hook - Check lifting and travelling performance - Check safety equipment	Monthly	- Check End-stop system
		As needed basis	- Check travelling speed - Check hoist rails, structure & support
8. CHLORINE CONTACT TANK INLET CHANNEL			
Motored Chlorine Injectors (In-line)	- Check Smooth-Operation - Check motor running - Check Chorine residual in chlorine contact tank - Check abnormal noise & vibration - Check chlorine gas leakage by ammonia liquor - Check Gas pressure gauge, vacuum gauge, gas flow meter - Check safety equipment	Weekly	- Check damage of chlorine gas supply line - Check backflow prevention valve - Check leakage of chlorine solution
		Yearly	- Check the injector maintenance lifting equipment for performance - Check in-line injector performance and smoothness
9. CHLORINE BUILDING			
Chlorinators	- Check solution leakage and/or chlorine gas - Check Gas pressure gauge, gas flow meter - Check dosing rate/amount - Check chlorine gas rate valves, check valves& pipeline - Check safety equipment	Weekly	- Check total System
Chorine Cylinders (Ton)	- Check chlorine gas / solution leakage - Check no gas leakage, and no wet or keep dry in the room	Weekly	- Check Condition of the cylinder-material and Safety valve - Check storage way

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
	- Check room temperature & humidity - Check Gas header, pipeline& gasket - Check safety equipment		- Classification of cylinder as new or empty, and check the stock - Cleaning
Cylinder Scales	- -Cleaning weight area	Weekly	- Check measuring error
Cylinder Lifting Equipment& Hoist	- Check Smooth-Operation - Check lifting equipment - Check lifting and travelling performance - Check safety equipment	Monthly	- Check End-stop system
		As needed basis	- Check travelling speed - Check hoist rails, structure & support
Safety Equipment	- Check performance of chlorine gas detectors and sensors, Ventilation system - Check sequence of Auto / manual mode - Check safety equipment	Weekly	- Clean gas detector & sensors - Clean up the area installed detectors - Check safety shower performance
		Monthly	- Try-on oxygen mask, other safety appurtenances - Check Gas Leakage Repair Kits
Neutralization Equipment (Emergency Chlorine Scrubber)	- Check NaOH solution leakage from the tank /equipment /pipe/ valves - Check solution level-Check performance of splays, pumps - Check performance of exhaust blower - Check safety equipment	Weekly	- Check pH of NaOH solution
10. Mechanical THICKENER (As Applicable)			
	- Check Smooth-Operation-Abnormal noise - Removal scum - Check safety equipment	Weekly	- Check grease up & Oil level of reduction gears - Remove scum& cleaning - Clean algae on overflow weir, trough and wall - Clean up with water
		Monthly	- Check emergency stop system
		Every 6 Months	- Check peripheral velocity - Adjustment of shaft rotation speed

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
		Yearly	- Dry basins for checking of damage, space between rake and bottom floor, repair, paint & cleaning
11. PLANT DRAIN PUMPING STATION			
Pumps	- Check Smooth-Operation - Check discharge rate, pressure, abnormal noise - Check safety equipment	Monthly	- Check pump damage - Check the pump lifting equipment for performance and smoothness - Clean up with water
		Every 6 Months	- Check wear on pump impeller - Pump speed & rotation direction
		Every 1~3 Years	- Check pump performance
12. SLUDGE DEWATERING BULDING			
Sludge Storage tank Mixers	- Check Smooth-Operation - Check discharge rate, pressure, abnormal noise, bearing temperature & vibration - Check feeding rate to meet speed of dewatering equipment - Check sludge leakage - Check safety equipment	Weekly	- Check grease up & Oil level of reduction gear box - Check safety equipment - Clean-up with water
		As needed basis	- Check pump performance
Dewatering Centrifuges	- Check Smooth-Operation - Check pressure, abnormal noise, bearing temperature& vibration - Check feeding sludge concentration and ratio of Polymer dosing - Check cake moisture and G-value - Check SS in drain - Check emergency stop system - Check no liquids leakage from casing, loose bolts/Nuts/tighten - Check grease up & Oil level	Monthly	- Check quality of oil in reduction gear box - Check all safety equipment - Clean-up drain pipe of separate liquid
		Every 1~3 Years	- Check dewatering centrifuge performance
		As needed basis	- Check dewatering centrifuge system - Check space between screw and casing

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
	of reduction gear box - Check safety equipment		
Conveyer (Sludge Cake)	- Check Smooth-Operation - Abnormal noise - Meandering of a belt - Check Smooth-Operation - Check scraper performance - Check rollers-performance - Cleaning of Conveyor - Check safety equipment	Weekly	- Check grease up & Oils - Check emergency stop system
		Monthly	- Check damage to a belt - Check Slack of a belt & adjustment of take-up - Check Belt-speed
Cake Hopper	- Check Smooth-Operation - Check abnormal noise& vibration - Check gate operation on opening and closing - Check liquid leakage - Check no cake sludge bridge - Amount of cake sludge - Check safety equipment	Weekly	- Check grease up & Oils - Check gate performance - Check position of liquid trough - Check safety equipment
		As needed basis	- Check cake hopper assembly
Powder Polymer Storage Hopper	- Check Smooth-Operation - Check abnormal noise & vibration - Check polymer bridge - Check safety equipment	Weekly	- Check grease up & Oils - Cleaning dust off
		As needed basis	- Check powder polymer storage hopper assembly
Auto Feeder	- Check Smooth-Operation - Check abnormal noise &vibration - Check feeding rate - Clean-up feeder	Weekly	- Check feeding accuracy - Clean up feeder
		As needed basis	- Check the feeder performance
Polymer Tanks	- Check corrosion condition - Check leakage - Check drain & Overflow pipe	Weekly	- Remove deposition substance - Clean up tank & touch-up painting
Polymer Mixers	- Check Smooth-Operation - Check abnormal noise& vibration - Check mixing time - Check safety equipment	Weekly	- Clean up mixer
		Monthly	- Check mixing speed - Check shaft and coupling connection
Polymer Feeding Pumps	- Check Smooth-Operation - Check discharge rate,	Monthly	- Check accuracy of flow rate - Clean up with water

Name of Facility	Daily	Periodic	
	Point to be checked	**Frequency**	**Point to be checked**
	pressure, abnormal noise and vibration - Check safety equipment	Every 1~3 Year	- Check pump performance
Motorized Monorail Hoist	- Check Smooth-Operation - Check all lifting equipment including wire and hook - Check lifting and traveling performance - Check safety equipment	Monthly	- Check End-stop system
		As needed basis	- Check traveling speed - Check hoist rails, structure & support

16.9 Typical Electrical Items & Maintenance Requirements

Daily		Periodic	
Frequency	**Description**	**Frequency**	**Description**
Transformer	- Verification of KVA, V, A, - abnormal sound, current protection, oil temperature	Every 6 Months	- Verification of general performance, Verification of oil levels, silica gel in breather, OLTC, OTI, WTI, Buchholz relay, CTs etc ,testing of oil, verification of earth connections ,IR measurement.
11 kV Switchboard and Switchgears	- Verification of kVA, kW, kWh, V. - A, PF, Hz, healthiness of protections, indications. - Alarms, abnormal sound, burning. - Smell.	Every 6 Months	- Verification of condition of breakers, switches, relays, protective devices, earthing, wiring and connections.
PCC /MCCs/MLDB	- Verification of V, A, healthiness of protections, lamps, abnormal sound, burning smell	Every 6 Months	- Verification of condition of breakers, switches, pushbuttons, relays, protective devices, earthing, wiring and connections
Variable Frequency Drives	- Verification of Input & output voltage, current, frequency. - Verification of Indications, alarm & protections.	Every 6 Months	- Verification of condition of breakers, switches, pushbuttons, relays, protective devices, earthing, wiring and connections. - Verification of working of converter, inverter, DC Link. - Verification of Harmonic Distortion.

Daily		Periodic	
Frequency	**Description**	**Frequency**	**Description**
Lighting panels	- Verification of lamps, abnormal sound, burning smell.	Every 6 Months	- Verification of condition of breakers, switches, earthing, wiring and connections.
Meters reading	- Verification of V, Am, overload protection	Every 6 Months	- Verification of over load protection indication, switch On/Off, accuracy, damage
Diesel Generator Set	- Verification of Engine oil level, Engine oil leakage, air & oil filters, cooling fans, fuel level, water level etc. - Verification of battery voltage charging & self-start. - Verification of abnormal sound, vibrations etc. - Verification of Voltage, current, frequency, RPM, Indications, Alarms & Protections. - Verification of Oil leakage, fuel leakage. - Verification of Interconnecting Cable, earthing, loose connections etc.	Every 250 hours/6 Months	- Verification of Conditions of filters. - Verification of Condition of cooling fan. - Verification of Condition of battery & charger. - Verification of self-start system - Verification of condition of engine, alternator & accessories, doors of acoustic enclosure, exhaust system etc. - Verification of conditions of Breakers, Switches, Push Buttons, Relays etc. - Verification of Auto / Manual operation, all interlocks, synchronizing. - Verification of Indications, Alarms & Protections. - Verification of Condition of Interconnecting Cables, Connection & earthing, including Neutral Earthing of AC Generator.
Cable system	- Verification of short circuit, burning smell, loose connections, local heating.	Every 6 Months	- Verification of voltage drop, damage, insulation resistance
Lighting Fixtures	- Verification of working of lamps & ballasts.	Every 6 Months	- Verification of illumination level - Verification of condition of lamps & ballasts. - Cleaning of lighting fixtures. - Verification of wiring.
Switch board	- Verification of operation of switches, sockets.	Every 6 Months	- Verification of condition of switches, sockets & fan

Daily		Periodic	
Frequency	**Description**	**Frequency**	**Description**
			regulators. - Verification of wiring.
Switch Socket	- Verification of operation of Switch & Socket.	Every 6 Months	- Verification of condition of Switch & Sockets
Ceiling Fan	- Verification of operation of Fan.	Every 6 Months	- Verification of condition of ceiling fan. - Verification of condition of bearing, abnormal sound /noise.
Power sockets	- Verification of operation of MCB, Plug & Socket.	Every 6 Months	- Verification of condition of MCB, Socket & Wiring.
General	- Inspection of General appearance of various Electrical equipment /items. - Verification of Cable System for Short circuit, smell, damage etc.	Every 6 Months	- Verification of condition of cables, wires& connections. - Verification of Insulation resistance of individual equipment, cables and total system. - Verification of Condition of Earth Connections.

16.10 Electrical System Operation Practices

All the electrical equipment's shall be handled and operated by a trained and authorized person only. All the equipment shall be checked for its proper earthing and loose connections prior to start the equipment. Naked wire, loose connections and faulty connections shall be repaired immediately prior to start for operation.

Electrical sockets and switch shall not be touched by bare or wet hands. If there is any live wire found naked or on wet ground, main switch shall be turned off first then the wire shall be repaired or moved.

For any electrical works proper, insulated tools shall be used. Do not try to use tools made for other purpose; it may be hazardous.

16.11 Maintenance Practices - Instrumentation, Control & Automation

16.11.1 General Maintenance

A comprehensive maintenance program is critical to attaining long-term reliable performance of SCADA Systems / ICA systems. Periodic device calibration, preventive maintenance, and testing allow potential problems to be identified before they can cause mission failure. Prompt corrective maintenance assures reliability by minimizing downtime of redundant components.

The Contractor shall enter into AMC contracts with system / equipment suppliers of ICA, as necessary. It is mandatory for the Contractor to enter into an agreement for a 5 years operation and maintenance contract with the instrumentation, PLC and SCADA system supplier and wireless communication supplier or the authorized system integrator, whosoever has executed the work for this Contract.

16.11.2 Preventive Maintenance

The SCADA system should be part of the overall preventive maintenance (PM) program for the facility. Table below provides a list of recommended maintenance activities and frequencies for ICA systems & their components. Preventive maintenance schedules for ICA components and subsystems should be coordinated with those for the mechanical/electrical systems they serve to minimize overall scheduled down time.

Activity	Frequency
Pneumatic Systems/Components/Instruments	
Check Regulators and Filters	Monthly
Inspect Tubing and Piping	Monthly
Actuate Pressure Switches	3 months
Calibrate Switches and Sensors	Yearly
Calibrate Pressure Gauges	Yearly
Calibrate Level Transmitters	Yearly
Calibrate Flow transmitters	Yearly
Calibrate Pressure Transmitters	Yearly
Calibrate Thermometers	Yearly
Calibrate Analytical Instruments/Online Instruments (pH, ORP, Turbidity, etc.,)	6 Months
Change Sampling solution of Analytical Instruments	As required
Electronic Systems	
Lamp Test/Verify Indicators	Monthly
Inspect Enclosures for Dirt, Water, Heat	Monthly
Run PLC Diagnostics	3 Months
Calibrate Sensors and Transmitters	Yearly
Calibrate Meters	Yearly
PLC Communication Modules	Monthly
PLC Batteries	Yearly
Test Automatic control Sequences	Monthly
Verify Alarms	Weekly
Software Maintenance and Patching	3months
Anti-virus Definition Updates	Monthly
Inspect Wire, Cable and Connections	Monthly
Inter site Communication Network	Weekly
Dead Bus Relays	3 Months
UPS setting with SCADA	Weekly
PLC Redundant Power back up	Monthly
SCADA Redundancy	Monthly

Activity	Frequency
Network Redundancy	Weekly
PLC Hot-Standby	Monthly
Historian Package (Capacity)	Monthly
Data Archiving	Monthly

Notes:

a) *Many components of SCADA systems, such as dead-bus relays, are not required to function under, Normal system operating modes. For this reason, the system should be tested periodically under actual or simulated contingency conditions. These tests should approach as closely as possible the actual off Normal conditions in which the system must operate, For example, SCADA for Dual Redundant system should be tested by interrupting the utility source as far upstream of the normal service as possible.*

b) *Periodic system testing procedures can duplicate or be derived from the functional performance testing procedures.*

c) *The SCADA software maintenance should include timely updates of any new versions from the supplier and testing to verify proper installation on the SCADA computer. In addition, software antivirus updates should be maintained. This should be performed any time after the computer is connected to the Internet or the antivirus patch should be downloaded as and when the updates are available. Normal operation requires that the SCADA computer not be connected to the Internet.*

d) *Faulty Instruments, sensors, transmitters, communication modules, computer hardware should be replaced with new components. Repair of the items would not be accepted.*

16.11.3 Concurrent Maintenance

Concurrent maintenance is defined as testing, troubleshooting, repair or replacement of a component or subsystem while redundant component(s) or subsystem(s) are serving the load. The ability to perform concurrent maintenance is critical to attaining the specified reliability/availability criteria for facilities and must be designed into the SCADA system. Where SCADA components are associated with equipment that has redundancy and therefore are not themselves redundant, their maintenance should be scheduled to occur during maintenance of the associated equipment. SCADA components and controllers that are redundant must be capable of being taken out of service, repaired or replaced and tested without interfering with the operation of the redundant component.

16.11.4 Reliability-Centered Maintenance

Reliability-Centered Maintenance (RCM) is an approach for developing an effective and efficient maintenance program based on the reliability characteristics of the constituent parts and subsystems, economics, and safety. RCM provides a logical, structured framework for determining the optimum mix of applicable and effective maintenance activities needed to sustain the operational reliability of systems and equipment while ensuring their safe and economical operation and support.

A significant by product of the application of SCADA systems to the control of facilities is the large amount of operational data made available through the trending and data storage features of the SCADA. This operational data can be used for automated performance monitoring of mechanical and electrical systems that can support an RCM approach.

16.11.5 Operations and Maintenance Documentation

The Contractor should perform the O&M analysis to determine the O&M data required to support maintenance of the SCADA system. This analysis should be coordinated with Employer to determine

maintenance parameters and O&M data that are available. Typical O&M data requirements include the following items:

a) System documentation as defined in FDS, FAT & SAT documents
b) Minimum spare parts list.
c) Recommended spare parts list.
d) Recommended onsite test equipment.
e) Recommended O&M training.
f) Recommended O&M to be performed by Contractor

16.11.6 Spare Parts Stocking

An adequate on-site stock of spare parts is essential to obtaining high availability of ICA systems.

All spare parts used for the equipment in the maintenance of the system must be from the manufacturer of the equipment or, if the equipment itself has been made with parts from other manufacturers, the parts must be of the same make as used in the equipment supplied and installed.

All spare parts shall be packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be labelled on the outside of its packing with its description, number and purpose and, if more than one spare is packed in a single case, a general description of the case contents shall be shown on the outside and a packing list enclosed.

Minimum recommended stocking levels include the following. These quantities may need to be increased for components which are used in large numbers in the facility:

1) Manufacturer's recommended spare parts list.
2) One each of all line replaceable boards or modules.
3) Six each power and control fuses used in the system.
4) Tools required to terminate coaxial on fiber optic cables.

Automation:

1) Laptop computer loaded with software required to access controllers.
2) Licenses for all software installed on the system.
3) Permission to modify program code.
4) Spare cables for connecting computer to controllers.
5) PLC CPU, Power supply module, DI, DO, AI, AO modules, Communication module, protocol converter etc.
6) PLC batteries, fuses, etc.
7) Utilities & Consumables
    a. The contractor has to provide consumables for printers e.g.: Ink cartridges (color & B/W), A4, A3, A1 size of paper, printers for a period of 7 years.

Downtime of the above system should not exceed more than 2 hours.

16.11.7 Technical Support

The Contractor should specify functional areas of the operating system and/or equipment where a technical representative will be furnished by the manufacturer for training, test, checkout, validation, or pre-operational exercises.

Ongoing O&M of SCADA system software may require technical support from the system vendor or from agency technical personnel not located at the facility. Commercial SCADA software typically has provisions for remote modem access that permit this type of support from the vendor's location or an agency central engineering group. Such remote access provisions represent a vulnerability to

"hacking" and must be used with great caution. They should be monitored when in use and physically disconnected when not in use.

Password protection policies for all SCADA systems, including PLC's, shall be in compliance with established policies and to be agreed with the Employer's Representative.

These policies require that the default password that came from the control supplier be changed when Placed into operation at the facility.

Note: -

1) During commissioning, Trial run and testing the Charges / Costs towards the following items shall be borne by the contractor.
   - Network Operating charges for Wireless communication System (GPRS gateway)
   - Software updates, consumables and stationeries etc.,
   - Instrumentation (Analog) & Control Cables and Power Cables, OFC, etc. If any required.
   - Painting for field Instrument enclosures.
2) During O&M Period:
   - Contractor shall Quote Network Operating charges for Wireless communication (GPRS gateway) yearly wise.

16.12 Annual Maintenance Contract

For all ICA works Contractor shall enter in to an Annual Maintenance Contract (AMC) with system integrators, who have executed the works under this contract. The AMC shall include periodic maintenance of all Field instrumentation, analytical instrumentation, real time multi parameter Influent and effluent monitoring systems, lab equipment, Control and automation system inclusive of PLC based SCADA system and wireless communication equipment. The AMC shall include periodic painting of all instrumentation enclosures, panels as required. The AMC shall also include supply of required spares and consumables as required for the complete ICA equipment throughout the O&M period. The contractor shall depute trained personnel from the vendor for carrying out AMC tasks as required under this contract.

The contractor is required to submit an AMC agreement with the system integrators (for Field instrumentation, analytical instrumentation, real time multi parameter Influent and effluent monitoring systems. Lab equipment, Control and automation system inclusive of PLC based SCADA system and wireless communication equipment.) After the conduction of SAT and before applying for completion of Test on Completion certificate. The same shall be verified before issuance of test on completion certificate.

16.13 Prices for Operation and Maintenance

The Contractor, at the time of bidding, will be responsible to ensure the completeness and adequacy of his Bid Price to fulfil the entire responsibilities of Operation and Maintenance. Contractor bid price, as quoted on a yearly basis in the Schedule of Prices, shall include all costs for Operation and Maintenance.

16.14 Format

1. **Daily report of operation and maintenance of 10MLD Capacity TTP at Yelahanka**

- Consumption Record
- Quality Record
- Operation of TTP plant

2. **Monthly report of operation and maintenance of 10MLD Capacity TTP at Yelahanka**

- Consumption Record
- Quality Record
- Operation of TTP plant

16.15 Checklist for Hand Over at the end of O & M period

- This section applies to procedure on how to transfer the TTP plant at Yelahanka after 5 years period of operation and maintenance by the contractor. ICA checks to be done during handing over after O & M period.
- The specification of the plant includes complete sewerage treatment plant facility which shall operate the instrumentation system, communication system, SCADA system.
- The procedure of handover shall be verified through the final examination by the employer engineer through joint inspection.
- The Contractor shall handover the instrumentation, control and automation system documents, drawings, manuals and programs at the end of the operation and maintenance period.

A completion approval certificate for handover shall be issued after the successful final examination and submission of documents before the contract deadline by the employer.

16.16 Issue of Completion Certificate for Operation and Maintenance

Refer Part 17 for issue of completion certificate.

End of Part 16